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AN IN VITRO COMPARISON OF NON-VITAL BLEACHING TECHNIQUES IN THE--ETC(U)
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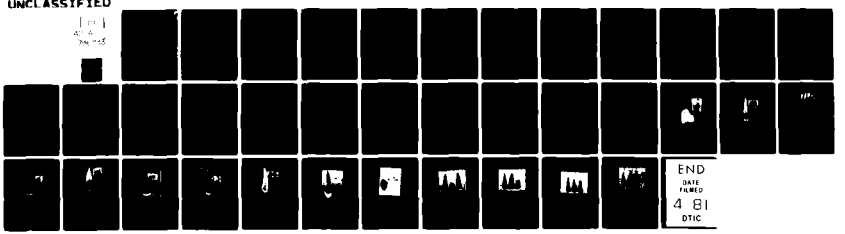

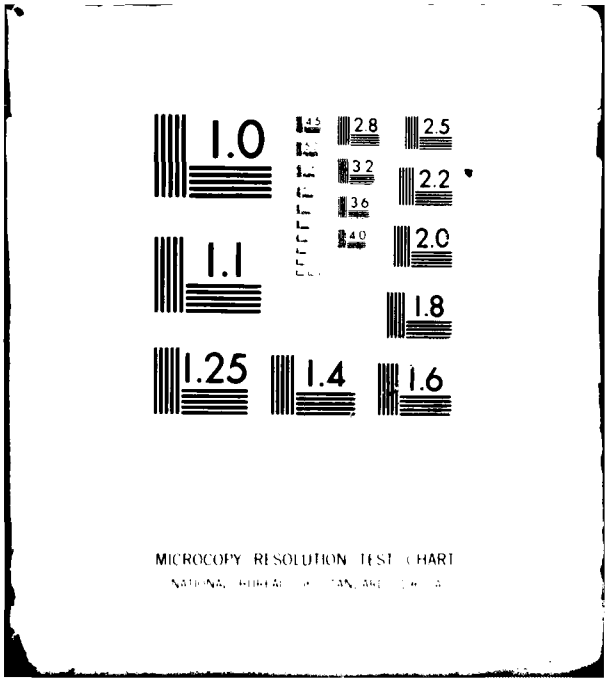
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This study utilizes teeth stained in vitro to compare and evaluate the results of three commonly used non-vital bleaching techniques: the thermocatalytic, the "walking bleach," and the combination. The three techniques were equally effective in bleaching crowns where pulpal hemorrhage was the primary cause of discoloration. The rapidity of the "walking bleach" technique in respect to a decrease of operator time was highly significant ($p<0.0000$).

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An In Vitro Comparison of Non-Vital Bleaching Techniques in the Discolored Tooth

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ABSTRACT

This study utilizes teeth stained *in vitro* to compare and evaluate the results of three commonly used non-vital bleaching techniques: the thermocatalytic, the "walking bleach," and the combination. The three techniques were equally effective in bleaching crowns where pulpal hemorrhage was the primary cause of discoloration. The rapidity of the "walking bleach" technique in respect to a decrease of operator time was highly significant ($p<0.0000$).

The bleaching of discolored non-vital teeth is an important phase of endodontic therapy. Bleaching is an attempt to restore normal shade to a tooth by decolorizing the stain with an oxidizing or reducing agent. Over the years, bleaching by oxidation has been the preferred method because of its simplicity and more certain results.[1] There have been two bleaching agents of choice, a 30-35% aqueous solution of hydrogen peroxide and powdered sodium perborate. They have been used either alone or in combination.[2,3]

Two basic techniques have been used widely to bleach the discolored pulpless tooth, the thermocatalytic and the "walking bleach" techniques.[2] The difference between the two techniques is only the method of effecting the release of nascent oxygen from the chemicals.

Through the years, the most prevalent method of bleaching has been the thermocatalytic technique in which heat is used to release nascent oxygen from the bleaching agent, usually 30% hydrogen peroxide. Heat sources have included photoflood lamps, "cherry, red hot" ball burnishers or plastic instruments, and electric heat producing instruments.[2,4,5]

The second technique, the "walking bleach," apparently originated with Spasser[1] and his use of sodium perborate. Sodium perborate in the dry state is a stable white powder. It is soluble in water and the solution decomposes into sodium metaborate and hydrogen peroxide releasing nascent oxygen. To bleach teeth, Spasser mixed a thick creamy paste of sodium perborate with water and sealed it into the

pulp chamber for varying periods of time.

Nutting and Poe[3] substituted 30% hydrogen peroxide solution for the water, reasoning that since both compounds release oxygen, their combination would be synergistic and more effective. Nutting and Poe first called this technique the "walking bleach" because the bleaching process actually occurs between dental appointments while the bleaching agents are sealed in the pulp chamber. Modifications of this technique have been reported subsequently by Cohen,[6] Serene and Snyder,[7] and Bellizzi.[8]

Just as Nutting and Poe[3] combined two oxidizing agents in an attempt to obtain a more favorable result, many practitioners today use a combination of the two bleaching techniques. The procedure is accomplished by using the thermocatalytic technique in the dental office followed by sealing the "walking bleach" paste into the pulp chamber between appointments. This is done in order to hopefully obtain a faster, more efficacious, and esthetic result.

The prognosis for success of any bleaching technique depends on the cause of the discoloration.[2,4] When the discoloration is due to products of pulpal decomposition within the dentinal tubules, the prognosis is usually excellent. When the discoloration is due to metallic stains or silver containing medicaments, bleaching is more difficult and it is sometimes not possible to achieve satisfactory results.[2,4] It also appears the probability of color reversal is much greater in these cases. Howell[9] has shown that the more difficult it is to bleach a tooth, the more likely it is to discolor again.

Frank[2] has stated "it is virtually impossible to make firm

and positive statements as to the comparative efficacy of the different bleaching techniques for pulpless teeth." Somewhat surprisingly, this appears to be an accurate statement. There do not appear to be any studies in the dental literature that scientifically compare different bleaching techniques. Therefore, the purpose of this study was to compare and evaluate the results of the three commonly used non-vital bleaching techniques: the thermocatalytic, the "walking bleach," and the combination. This evaluation related efficiency of the techniques in decolorizing stains and the amount of clinical time needed to perform the procedures.

MATERIALS AND METHODS

Thirty-nine extracted anterior teeth with intact crowns were immersed in 5.25% sodium hypochlorite solution for approximately eight hours to loosen extrinsic surface debris such as calculus, bone, soft tissue, and stain. The teeth were then scaled with an ultrasonic scaler and polished with a rubber cup and flour of pumice. Each tooth was then compared to standard shade guide teeth under daylight balanced lights. Their shades were recorded, and each tooth then photographed. The lightest tooth, the median, and the darkest tooth were designated as controls and were stored in physiologic saline. They were labeled A, B, and C, respectively.

The remaining 36 teeth were designated as experimental teeth and were prepared for staining as described previously.[10] Basically, the procedure consists of preparing lingual access openings in the teeth, extirpating the pulps, and staining the teeth using hemolyzed

red blood cells in a high-speed centrifuge.

After staining, the experimental teeth were again compared to the standard shade guide teeth. The shades were again recorded and the teeth rephotographed.

The 36 teeth were ranked lightest to darkest. Twelve test groups were made up of successive sets of three teeth each, i.e., group one would include the three lightest teeth, numbers one, two, and three; while group twelve would contain the three darkest teeth, numbers 34, 35, and 36. One tooth in each group was then selected randomly and assigned to one of the bleaching techniques. This provided a stratified sample for each treatment, with one tooth in each group receiving a different bleaching technique.[11]

As is performed clinically, prior to bleaching teeth by any of the three techniques, the crown of each tooth was polished with a rubber cup and flour of pumice to remove any extrinsic debris. To prevent the caustic bleaching agents from penetrating through the apical foramen, a layer (approximately 2mm) of IRM was placed in the root canal space. It was placed by measured instruments so it was 2mm below the cementoenamel junction. Subsequently, the dentin in the pulp chamber was freshened with a #4 or #6 round bur, and wiped with a cotton pellet moistened with chloroform to remove residual debris.

Thermocatalytic Technique

An electric bleaching instrument (Union Broach Corp., Long Island City, N.Y.) was selected as the heat source for this

technique. The instrument was preset to 153° F. The instrument has two interchangeable heat tips - one is concave to conform to the labial surface of anterior teeth, and the other is pick-shaped to enter the lingual access opening.

The procedure consisted of placing a portion of a dry cotton pellet in the pulp chamber. It was then saturated with 35% aqueous solution of hydrogen peroxide (Superoxol) delivered by a disposable endodontic syringe and needle. Heat was applied with the pick-shaped tip for a period of two minutes. This was followed by the concave tip being used to apply the heat for two minutes to wisps of Superoxol-saturated cotton fibers placed on the labial surface of the tooth. The saturated cotton was changed after each heat application. The heat was applied for three repetitions or a total of 12 minutes. The teeth were then dried and a dry cotton pellet was placed in the pulp chambers which were sealed with a temporary restoration (Cavit). The time for the actual bleaching procedure for each tooth was recorded. The teeth were then placed in individual vials in an environment of 100% humidity and maintained at 37° C for seven days. The procedure was then repeated and the time of actual bleaching again recorded. Upon completion of bleaching, the pulp chambers were filled with cotton, the temporary restorations replaced, and the teeth again stored in the same environment at 37° C. At one week and again at four weeks after the final bleach, the teeth were evaluated for color change using the shade guide teeth. The shades were again recorded and the teeth rephotographed.

"Walking Bleach" Technique"

For this technique a mixture of Superoxol and powdered sodium perborate were combined into a thick white paste. The paste was carried to the pulp chamber by means of a plastic instrument until the lingual access was filled. The paste was blotted dry with a cotton pellet. A lingual cavity preparation was prepared with the plastic instrument and sealed with a temporary restoration (Cavit). The time for the bleaching procedure was recorded. The teeth were again placed in vials and maintained in an environment of 100% humidity at 37^{o} C for seven days. The procedure was then repeated. Again after seven days, the paste was removed, cotton placed in the chambers, the temporary restorations replaced, and the clinical time again recorded. The teeth were again stored in a humid environment at 37^{o} C. At one week and again at four weeks after the final bleach, the teeth were evaluated for color change with the shade guide teeth. The shades were recorded and the teeth rephotographed.

Combination Technique

The 12 teeth in this group first underwent the thermocatalytic treatment as described. A "walking bleach" paste was then sealed in the pulp chambers. The total time for the actual clinical procedure for each tooth was again recorded. The teeth were again placed in vials in an environment of 100% humidity and maintained at 37^{o} C for seven days. At that time, the pulp chambers were reopened and the thermocatalytic technique repeated. After drying the teeth, dry cotton pellets were placed in the pulp chambers, and the temporary

restorations were replaced. Again, the clinical time was recorded. The teeth were also stored in a 100% humid environment at 37^0 C. At one week and again at four weeks after the final bleach, the teeth were evaluated for color change with the shade guide. The shades were recorded and the teeth rephotographed.

The efficiency of each bleaching technique was based on the degree to which the experimentally stained teeth were returned to their original shade.

RESULTS

Regardless of what the original shades were, the staining technique produced 31 teeth with crowns stained darker than the darkest shade guide tooth; two teeth were stained as dark as the darkest shade guide tooth; and three teeth were stained to a shade extremely close to the darkest shade guide tooth (Fig 1, 2, 3).

The results of the three different bleaching procedures are displayed in Figures 1, 2, and 3. There were no differences among the three techniques in their ability to bleach the crowns of the experimental teeth.

The crowns of all teeth were bleached lighter than their stained shades (Fig 4-6). The crowns of 34 teeth were bleached lighter than their original shades; while two teeth were bleached back to the same shades as the original.

The average time required to perform each bleaching procedure is presented in Table 1. A statistical analysis using the Student's t-test showed the "walking bleach" to use significantly less time

than the other techniques ($p<0.0000$).

Cavit was used as the temporary restoration between bleaching procedures. It was observed that 8/24 of the temporary restorations in the "walking bleach" and combination test groups were defective after seven days (Fig 7). None of the temporary restorations in the thermocatalytic group were defective at that time.

Surprisingly, the roots of the teeth bleached with the thermocatalytic and combination techniques were bleached back to their original shades. However, the roots of those teeth in the "walking bleach" test group still retained enough stain so that, in most cases, a visible distinction could be made in each test group (Fig 8).

DISCUSSION

Clinically, when a patient presents with a non-vital discolored tooth, the dentist must make a decision to take one of three approaches short of extraction: to leave the tooth alone; to bleach it; or to restore it with a crown. If the decision to bleach the tooth is made, the particular bleaching procedure selected is probably based largely on empirical data such as personal preference, instructor bias, and previous clinical experience, with little scientific data supporting that decision. Therefore, in order to study the various bleaching techniques the "stained tooth" model described previously was utilized.[10]

The experimental teeth with lingual access openings were placed in 5.25% sodium hypochlorite solution for 24 hours to open the dentinal tubules. During development of the experimental model, reevaluation of color was made at this time. Surprisingly, there was basically no change in shade following the lingual access preparation

and 24 hours in bleach. Therefore, in this study the reevaluation at 24 hours was not performed.

In agreement with Robertson and Melfi,[12] the electric bleaching instrument used in this study was found to be inaccurate with respect to its dial reading and the temperature at the tip. However, unlike Robertson and Melfi's study, the instrument used in this study was cooler, not hotter than the dial setting indicated. The bleaching instrument was calibrated at room temperature with a glass/mercury thermometer wired to the concave heating tip and covered with aluminum foil. The highest temperature recorded was 153^{0} F when the rheostat dial on the bleaching instrument was set to its maximum reading (greater than 200). The manufacturer does not state whether the numbers on the rheostat dial refer to degrees Centigrade or Fahrenheit. The manufacturer does recommend using a temperature of "125 to 140" on vital teeth and a temperature of "140 to 160" on endodontically treated teeth. Corcoran and Zillich[5] used temperatures of 140^{0} F to 160^{0} F for vital bleaching. Therefore, the 153^{0} F used in this study is within these guidelines. It is felt that the electric bleaching instrument needs redesigning to enable greater accuracy in temperature control.

When performing the combination technique, it was not necessary to place a second "walking bleach" paste in the teeth after seven days. After the second thermocatalytic portion of the procedure was complete, the teeth were at least one shade lighter than the original shades.

When Cavit was used as the temporary restoration between bleaching

procedures with the "walking bleach" and the combination techniques, eight of these restorations were observed to be defective, i.e., cracked restorations, and raised or open margins (Fig 7). When each tooth contained a large amount of "walking bleach" paste in the pulp chamber, placing a thin layer of Cavit was not adequate to properly seal the access opening. It is quite possible that the oxidation process of the "walking bleach" paste contributed to these defects, since no defects were observed in the teeth that received only the thermocatalytic treatment. Although leakage of oral contaminants was not a factor in this study, it most certainly would be clinically. Therefore, it is recommended that IRM be used as the temporary restoration of choice between bleaching appointments.[13]

Clinically, after a period of time, bleached teeth usually undergo a post-bleach reversal to a slightly darker shade. This reversal is probably due to a combination of extrinsic stains from oral contamination and rehydration of the teeth. In this study, the experimental teeth were stored in 100% humidity at 37^{o} C for four weeks following final treatment before the final evaluation was conducted. Minimal post-bleach reversals occurred in three teeth (Fig 1, 3) probably due to rehydration, since extrinsic staining from oral contamination was not a factor.

The "walking bleach" technique used the least clinical time when compared to the thermocatalytic and combination techniques. These times were recorded for the bleaching procedures only. Preparation time and time required to place temporary restorations were not included.

The observation was made that the roots of those teeth bleached with the thermocatalytic and combination techniques were bleached back to their original shades, yet the roots of those teeth which underwent the "walking bleach" retained some stain. This phenomenon of root bleaching may correlate to the seven cases reported by Harrington and Natkin.[14] In their study, external resorption of cervical crown and root structure may have resulted from the bleaching of endodontically treated pulpless teeth using caustic bleaching agents and a heat source. The possibility that Superoxol, with heat as its driving force, could diffuse through dentinal tubules to initiate an inflammatory resorptive process in the cervical area of the periodontal ligament space appears to be a reasonable hypothesis. This study appears to give some support to the hypothesis since it was observed that without exception, the roots of teeth receiving the added heat treatment were bleached to the point of being completely devoid of stain (Fig 8). Further research is required in this area.

The question remains of how to most esthetically restore the pulp chamber and access openings of endodontically treated teeth subsequent to bleaching. This is currently being investigated.

SUMMARY AND CONCLUSIONS

This study utilizes teeth stained *in vitro* to compare and evaluate the results of three commonly used non-vital bleaching techniques: the thermocatalytic technique, the "walking bleach" technique, and the combination technique. The three techniques were equally

effective in bleaching crowns where pulpal hemorrhage was the primary cause of discoloration. The "walking bleach" technique used significantly less clinical time.

LEGEND

Fig 1 The shades of the teeth in the thermocatalytic group at four stages of the experiment (O,S,1,4). Tooth types: central incisor (C); lateral incisor (L); cuspid (i).

Fig 2 The shades of the teeth in the "walking bleach" group at four stages of the experiment (O,S,1,4). Tooth types: central incisor (C); lateral incisor (L); cuspid (i).

Fig 3 The shades of the teeth in the combination group at four stages of the experiment (C,S,1,4). Tooth types: central incisor (C); lateral incisor (L); cuspid (i).

Fig 4 "Walking Bleach" technique.

A. Original shade; B. Stained; C. Post-bleach shade.

Fig 5 Thermocatalytic technique.

A. Original shade; B. Stained; C. Post-bleach shade.

Fig 6 Combination technique.

A. Original shade; B. Stained; C. Post-bleach shade.

Fig 7 Example of a defective temporary restoration observed between bleaching procedures.

Fig 8 Examples of how the teeth in the "walking bleach" test group retained the stain (Roots #23, 15, 18, 19).

A. Root #23 remains heavily stained.

B. Root #15, apical one-half remains stained.

C. Root #18, apical one-third remains stained.

D. Root #19 lightly stained.

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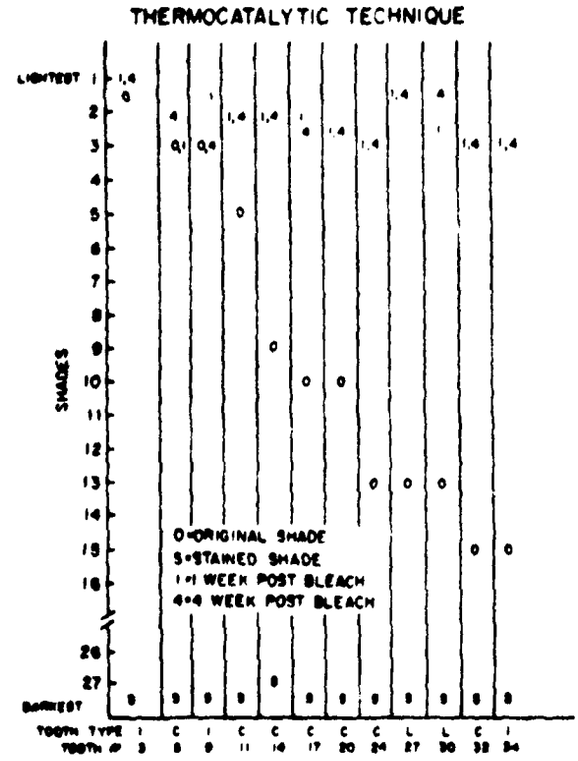
TABLE 1. Average time required per appointment to perform bleaching procedures*

"Walking Bleach"	1 min. 41 sec.
Thermocatalytic	16 min. 23 sec.
Combination	18 min. 28 sec.

*Times recorded are for bleaching procedures only. Preparation time and time required to place a temporary restoration are not included.


THERMOCATALYTIC TECHNIQUE
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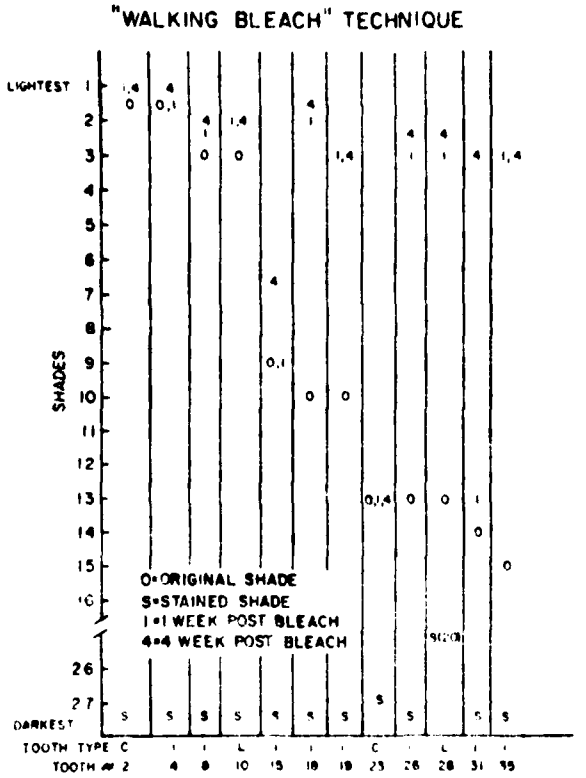
SHADES
DARKEST
O=ORIGINAL SHADE
S=STAINED SHADE
1=1 WEEK POST BLEACH
4=4 WEEK POST BLEACH
TOOTH TYPE
TOOTH #

FIGURE 1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SHADES
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O=ORIGINAL SHADE
S=STAINED SHADE
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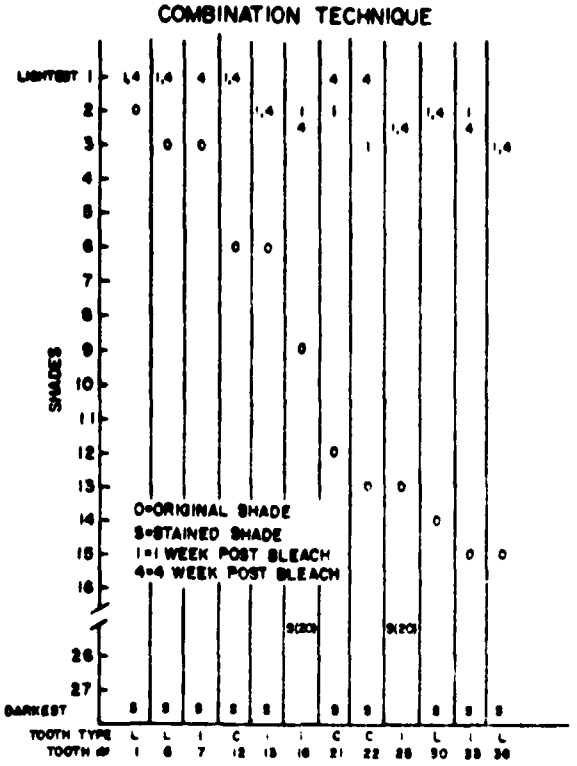
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DARKEST
SHADES
O=ORIGINAL SHADE
S=STAINED SHADE
1=1 WEEK POST BLEACH
4=4 WEEK POST BLEACH
TOOTH TYPE
TOOTH #

FIGURE 3

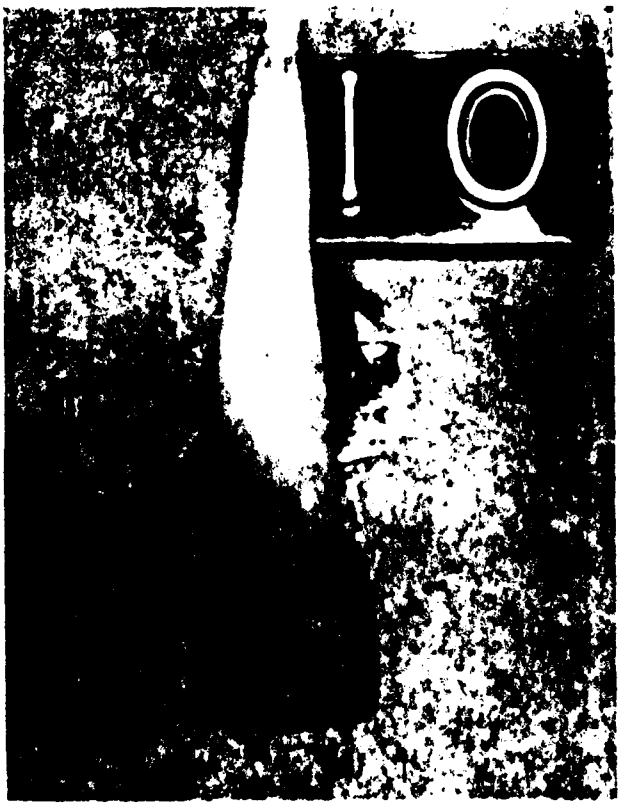
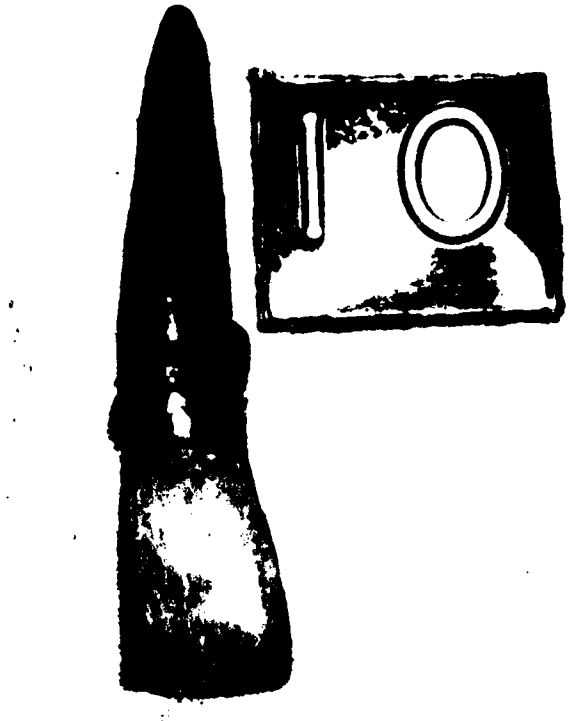


FIGURE 4A



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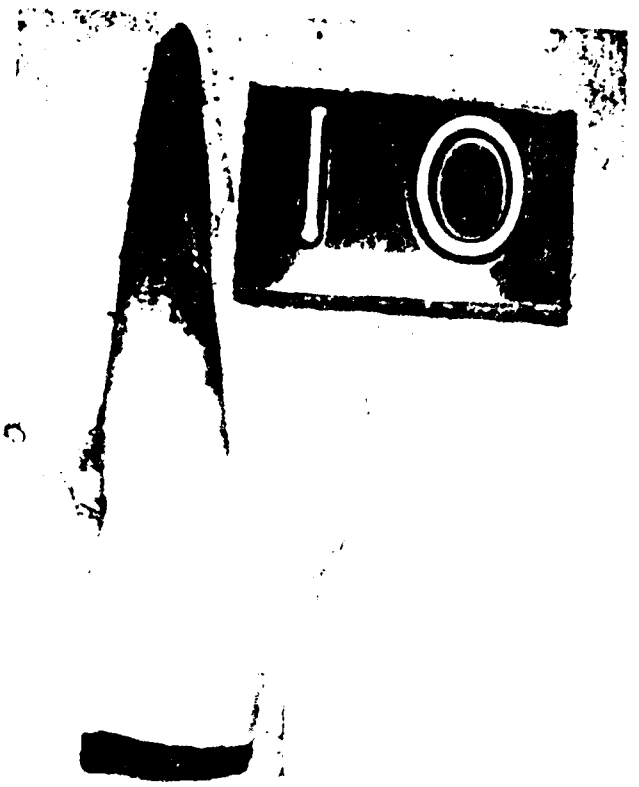


FIGURE 4C

FIGURE 5A

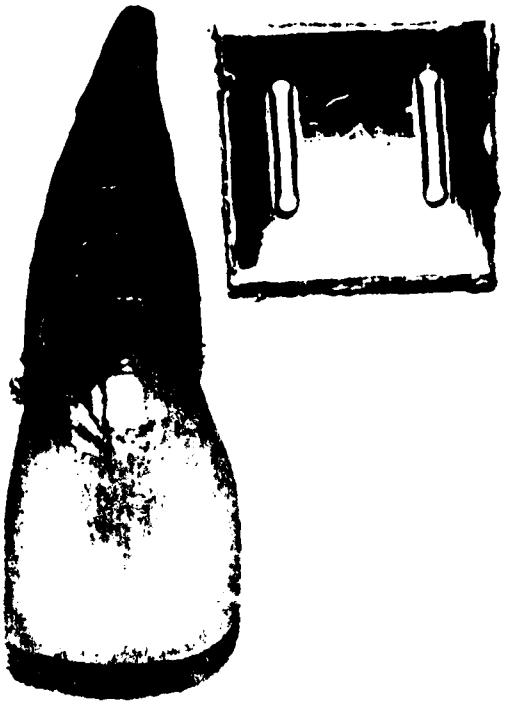


FIGURE 5B

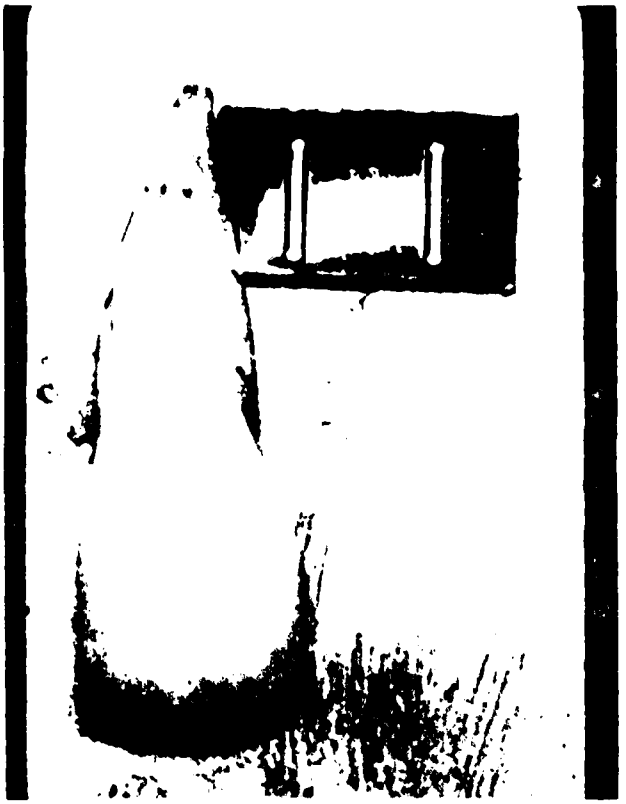


FIGURE 5C

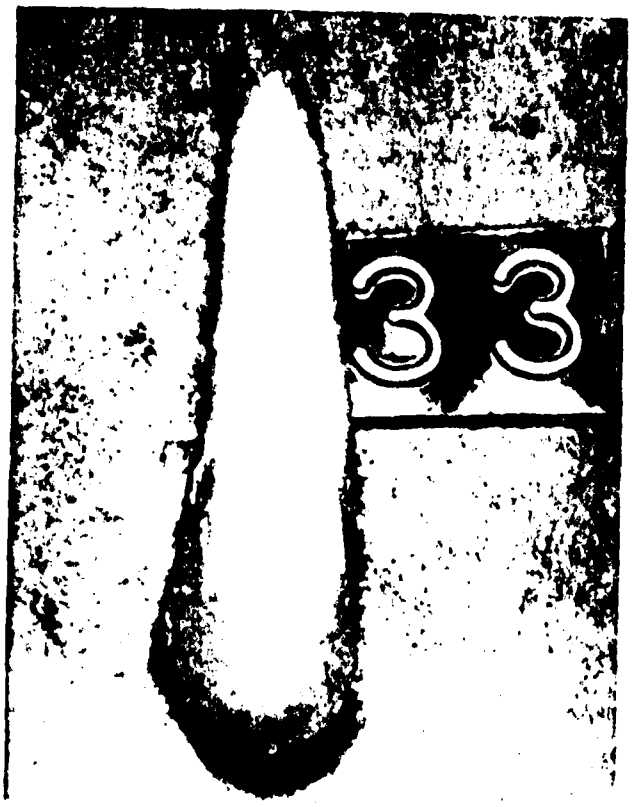


FIGURE 6A

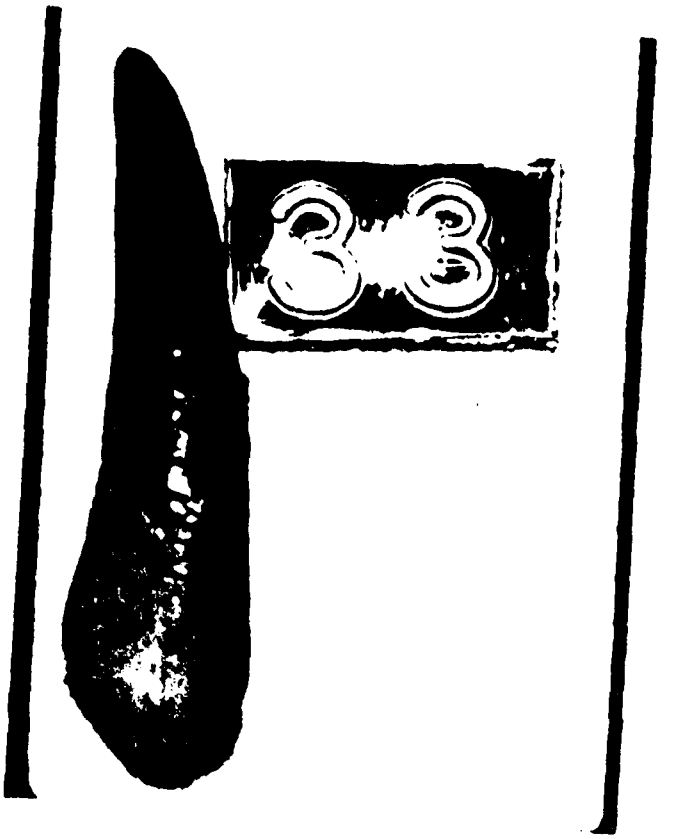
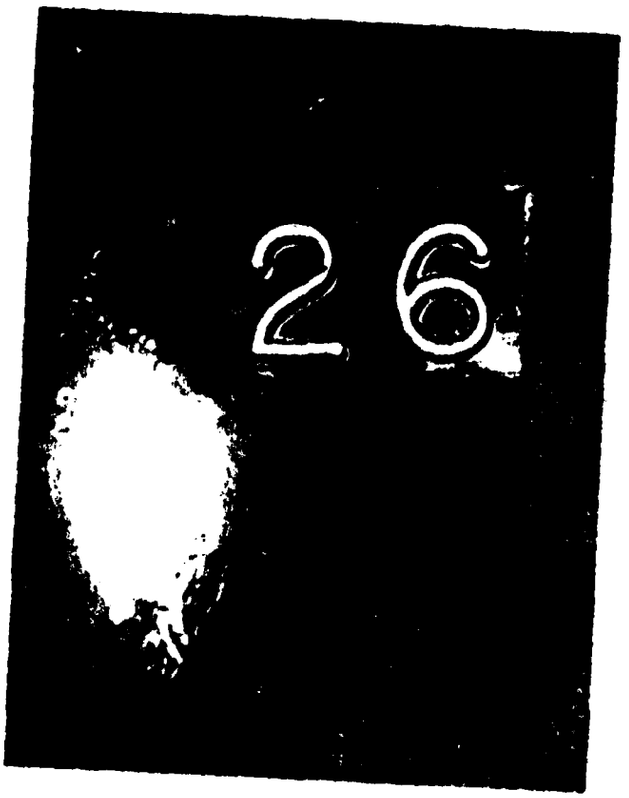


FIGURE 6B

FIGURE 6C



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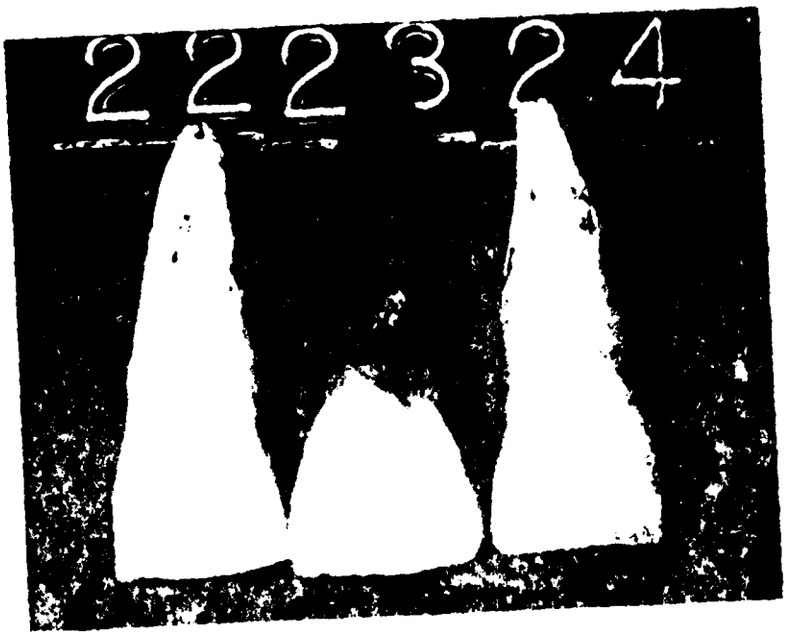


FIGURE 8A

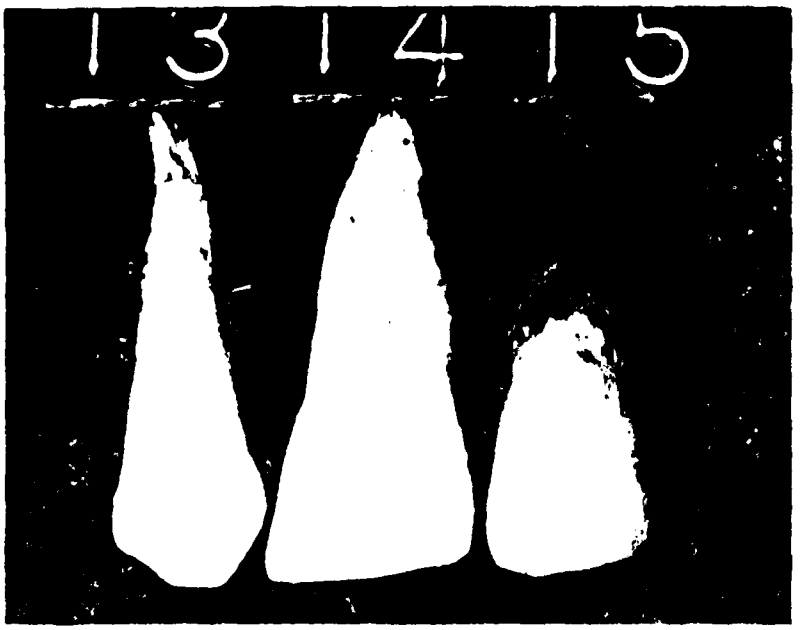


FIGURE 86

FIGURE 8C

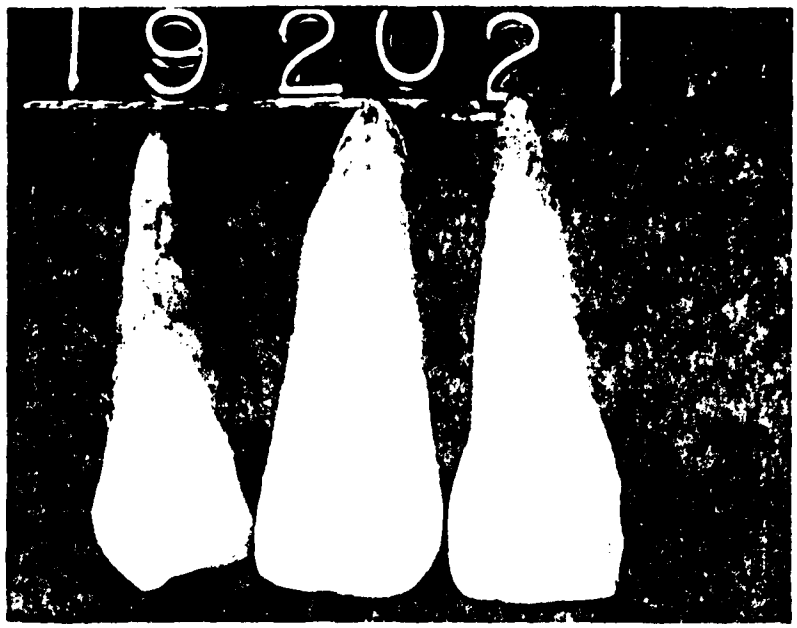
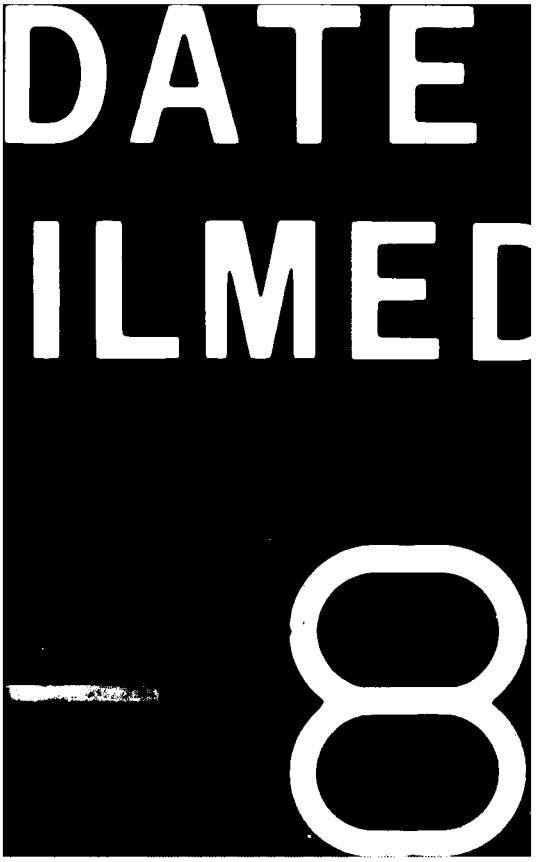


FIGURE 8D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